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Transparencies for overhead projectors developed under the leadership of the Texas Education Agency for regular public school classes were modified for use with deaf students by five teachers in the Texas School for the Deaf and a total of 60 sets of modified and unmodified visuals (5000 visuals) was made. Seven schools for the deaf in widely separated areas of the United States agreed to use both the modified and unmodified visuals on an experimental basis, in comparable classes (60 in all with 514 students), both classes having the same teacher. Student age, intelligence, and level of pretest performance were held constant statistically. Analysis of the pre- and posttest data by a statistician indicated no significant difference in achievement between experimental and control groups. There was, however, a highly significant difference between teachers on the subjects taught: earth science, $p=.0008$; modern mathematics, $p=.00005$; algebra, $p=.00005$; geometry, $p=.00005$; and world geography, $p=.00005$. The project identified desirable modifications and some characteristics of high quality overhead transparencies for the deaf, and it was concluded that using a sizeable number of consultants in a cooperative approach to educational research is a successful and efficient method. (Author/SN)

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TEXAS EDUCATION AGENCY
AUSTIN, TEXAS

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Sincere appreciation is expressed to the almost 50 participating teachers and supervising teachers of the deaf and their students for whom this project was designed and through whom its goals were accomplished.

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Dean Cunningham
Project Coordinator

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I. PROBLEM

Introduction

Few of today's problems in education are as serious as those which arise in the education of the deaf. However, research pertaining to the education of the deaf person has steadily advanced.

The natural progression has been from patterning instructional programs after those devised for public school classes toward more specialized instructional programs particularly suited to the education of deaf children. Through necessity, perhaps, there has been a tendency in the past to pattern the instructional program for the deaf after that for the hearing.

Concerning the education of the deaf, S. R. Silverman[1] states:

> A rational attitude points to the recognition that deafness imposes certain unavoidable limitations that must be accepted. At the same time, proper education in its broadest sense strives to relate the deaf person to the world about him in a psychologically satisfying way.

One of the "unavoidable" limitations which must be accepted is the fact that instructional programs created for regular school classes do not completely satisfy the educational needs of the deaf student. Therefore, there may be a need for specialized instructional materials for use in schools for the deaf. Leo S. Connor,[2] after a study of research in the education of the deaf, states:

> Despite the notable gains and even more exciting prospects the quantity and quality of research in the education of deaf children remains disappointing and low, and its application in the instructional realm is almost nonexistent.

John Gough,[3] Director of Captioned Films for the Deaf, U. S. Office of Education, in an article appearing in the Volta Review, states:

> Because of the language and communications problems of the deaf, instructional materials designed for ordinary school use oftentimes are not precisely suited for use in the classroom for hearing-impaired children. As a result, teachers of the deaf are constantly faced with the problems of revising, supplementing, inventing or condensing materials which come to them through normal channels.

Also in the Volta Review, Peter J. Owsley,[4] Assistant Headmaster of the Pennsylvania School for the Deaf, lists the limited research in educational methodology for teaching the deaf as one of eight issues confronting educators of the deaf.

In recognition of a need for research in this area, the Texas Education Agency was granted a $75, 473 contract under Title VII-A of the National Defense Education Act to support this research project which began June 1, 1965, for the purpose of modifying and testing overhead projection transparencies for special use with classes for the deaf.

The Instructional Media Division of the Texas Education Agency had, under a previous National Defense Education Act grant, developed overhead projection transparencies for the subject areas of secondary science, mathematics, English, modern foreign languages, and geography for regular public school classes. This project resulted in the development of more than 2, 000 transparency masters for these subjects. These transparency masters are available at a low cost through a commercial publisher. Five of these subject areas were chosen for modification and testing with the deaf.

The three major objectives of this project for the deaf were:

1. To determine what refinements and modifications were necessary to adapt transparency visuals designed for regular public school classes to meet the specialized instructional program needs of totally deaf students
2. To ascertain whether special modifications on visuals designed for regular public schools significantly increase achievement levels of deaf students above achievement levels of other deaf students using unmodified visuals
3. To utilize the Texas-developed overhead projection transparencies to study the need for visual materials in the instruction of deaf students

Initial modification of the regular public school visuals in five subject areas was completed in an experimental unit of the Texas School for the Deaf. The five subject areas were Modern Mathematics (grade 7), Modern Algebra (grade 9), Modern Geometry (unified course), World Geography, and Modern Earth Science (for use as a separate course or as part of General Science). A committee of specialists in instruction of the deaf and in subject matter areas reviewed each of the approximately 500 visuals and recommended modification based upon evaluations and suggestions completed by participating teachers.

Although modification of the visuals was limited to Texas, six other state schools for the deaf participated in the testing phase. These schools were chosen on the basis of desire to participate, geographic location, and size of classes which could be used for the testing of the visuals. The schools finally chosen were the Texas School for the Deaf; the American School for the Deaf (Connecticut); the Georgia School for the Deaf; the Florida School for the Deaf, and Blind; the North Carolina School for the Deaf; and the California schools for the Deaf in California at Berkeley and Riverside.

To test the subject-area visuals, the classes in each school were randomly assigned to an experimental group and a control group. The control group was taught with unmodified visuals (those created and tested for regular public school classes); the experimental group was taught with the new modified visuals created specifically for the deaf. In each subject area, one teacher taught both the experimental and control classes as much alike as possible. The project results were based upon the use of a pre-test and post-test which consisted of a set of questions covering the main concepts of the visuals, one question for each visual. The scores were analyzed in several ways to determine the influence of various aspects of this design.

A report[5] entitled "The Review and Recommendations of the Department of Health, Education and Welfare on the Report to the Secretary on the Education of the Deaf," states:

> There is a need for a bold new approach to the problem (of educating the deaf)--one characterized by open-mindedness and willingness to see the education of the deaf not as an isolated problem, but as one which has much in common with the learning problems of other groups of handicapped persons.

This project, although designed for the deaf, has application to the general field of special education. Some of the findings relate to the education of other handicapped groups, for example, educable mentally retarded.

Review of the Literature

The Overhead Projector

Dr. Marshal S. Hester,[6] Project Director, New Mexico Foundation, Captioned Films for the Deaf, has said:

> It is my candid opinion that the overhead projector constitutes the first major increment in the tools with which we teach the deaf since the development of the hearing aid. The overhead projector provides the opportunity to present the children with images so that the teacher and child have the same image in mind and provides the opportunity for the child to put the symbol with the image so the child has no doubt about what symbol belongs to what image.

The overhead projector has been used by the military service for more than twenty years and is certainly no newcomer to the field of instructional devices. Its size and expense kept it out of reach of most educators for a period of time. With the advent of low cost, light weight projectors during the past five years, and an increase in educational budgets for new instructional materials and equipment, the overhead has suddenly become a favorite instructional device. It has a unique contribution to make in the realm of instructional media and especially in the instructional program of deaf students. Richard Smith[7] says:

> The overhead projector is perhaps the most versatile of all the new media devices. It can be used to project transparent solids such as a slide rule. It can project opaque objects such as two geometric shapes or parts of a mathematical set. It will accept teacher-made transparencies or commercially produced transparencies for projection. It can be used to reveal only portions of a transparency or multiple overlays to develop sequential steps in a dynamic way. Acceptable visuals can be prepared for projection on the overhead without any cameras or machines of any kind, or it can simply be used as a chalkboard to write on during the instructional period.

One distinct advantage of the overhead system is the fact that little or no light control is required. It requires relatively little enlargement and consequently gives much more light on the screen. There is no need to render the room completely dark and in most cases it is not even necessary to turn off the lights.

The overhead projector is an extension of the teacher's communication skills and involves the teacher directly in instruction. The teacher using an overhead is not only at the front of the class, but can face the class at all times. The teacher is more involved in instruction than ever before.

The overhead projector allows a teacher at the desk to direct attention from the screen, on which an image is projected, back to the teacher by merely flipping the switch on the overhead projector. When the image disappears from the screen, the child's attention naturally returns to the teacher. As a result, it is possible to see the movement of the teacher's lips and also, when necessary, it is easy to see the teacher using the language of signs or finger spelling.

In support of the use of the overhead projector is a study performed by Mott[8] as early as 1899, which indicated that eight year old deaf children were superior in memory and observation to eight year old hearing children. Later, in 1903, Smith[9] reported that brighter deaf subjects were superior to slower ones in immediate and delayed visual retention. Both of these studies were supplemented by C. P. Goetzinger and T. G. Huber[10] in a report entitled "A Study of the Immediate and Delayed Visual Retention with Deaf and Hearing Adolescence" in the American Annals of the Deaf, May, 1964.

Audio-Visual Materials

In an investigation of audio-visual materials in parent education programs, Edgar L. Lowell[11] of the John Tracy Clinic reports:

> It is clear that, as was expected to be the case, the audio-visual materials successfully increased information levels, not only at the conclusion of the meetings, but also after a period of delay.

In further support of the use of audio-visual media, Kenneth Norberg[12] states:

> It is known with a high degree of certainty that people learn from films, television, programed instruction, and many other kinds of audio-visual materials, and that such factors as formal presentation, repetition, participation, attention-directing devices, rate of development, camera angle in film and television, and various methods of utilization affect the amount of learning.

Norberg further states that pictures may be more effective than words in instruction when a dramatic impact is desired or the learner has

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Norberg further states that pictures may be more effective than words in instruction when a dramatic impact is desired or the learner has not made the connections between verbal symbols and their reference. This supports Dr. Marshal Hester's conclusion that the overhead projector provides the opportunity to present children with images so that the child has no doubt about what symbol belongs to what image.

Instructional Problems and Achievement

In an article entitled "Educational Media in Teaching the Deaf Child," Mr. William D. Jackson[13] states, "deafness is a communication handicap." Extensive research is currently being conducted in the field of medicine and related areas such as audiology, psychology, and acoustics. Increased emphasis is also given to a variety of new media and instructional materials. Mr. Jackson reports on the development of classes and schools for the deaf, stating that the day class programs, public and private, throughout the country now number some 300 with more than 9,000 students. The total deaf and hard-of-hearing student population enrolled in all types of schools and programs in the United States has been estimated at more than 30,000. He further stresses the importance of visual communication for the deaf student pointing out that lighting, screen placement, viewing angles, desk arrangement, room acoustics, ventilation, and numerous other factors are often neglected when designing classrooms for the deaf. He points out an advantage of the overhead projector in a classroom for the deaf is that light from the projector illuminates the teacher's face in such a way that lip reading is enhanced and finger spelling is possible in semi-darkness. He states that there appears to be some research evidence which indicates that the placement of light on a person's face when using the overhead projector helps to highlight tongue, lip, and teeth placement, enabling deaf students to recognize certain words more easily.

Dr. Leonard M. Elstad,[14] President of Gallaudet College, reports, in an Associated Press newspaper interview, that "there are an estimated 300, 000 deaf persons in the United States whose basic problem is communication." With such emphasis placed upon communication in the education of the deaf, the newer media, including the overhead projector, become more and more important in teaching the deaf.

Dr. William J. McClure [15] states:

> The changing population has created problems in schools for the the deaf. Forty years ago two-fifths of our pupils had acquired language and communication ability before becoming deaf. There is much less adventitious deafness now. Now 87 or 88 percent of the children in most schools for the deaf are congenitally deaf or lost their hearing before language patterns were established. The great majority of schools for the deaf are continuing to use the traditional methods of communication for instruction, speech, lip reading, and auditory training with a population for which this type of communication is most difficult.

Dr. McClure cites a paper prepared by Dr. Marshal Hester on Manual Communication which was given at the International Congress on Education of the Deaf in 1963. Dr. Hester made a study of achievement test scores of 1, 004 students of 16 and older who left schools for the deaf during the 1961-62 school year. This study revealed that 501 graduates and 603 non-graduates had achievement levels somewhere between sixth and seventh grade. The 501 graduates ranged from 3. 1 to 12. 8 grade level.

The median was 8.1 and the mean was 7.9. The 603 non-graduates had a grade range of .9 to 10.5. The median for this group was 4.7 as was the mean. This would indicate that one of the factors which contributes to the low achievement level of graduates and non-graduates from schools for the deaf was the reduced communication ability of the child and the resulting retardation in the rate of learning.

Similar studies reported by Dr. Edmund Boatner[16] of the American School for the Deaf, and by David Denton,[17] of the North Carolina School for the Deaf, both support these findings. Mr. Denton, incidentally, also reported data which seemed to indicate that academic growth was much more rapid below the age of 12. To raise the achievement level substantially, increased attention should be directed to the child below 12 whose language patterns are being established.

The Problem of Communication in Instruction

In 1959 Dr. Edgar Lowell[18] reported on a research experiment in the use of lip reading and its relationship to language development. On a film test of lip reading, Dr. Lowell and his associates found that the high school level deaf students understood only 25.7 percent of the material presented to them. Hearing students at the same level without instruction in lip reading understood 37.6 percent. The conclusion is that a deaf child, who understands far less than half of what is presented to him by lip reading, is at a tremendous disadvantage in acquiring an education when lip reading is the principal method of communication.

Herbert R. Kohl,[19] in a policy study report published by the Center for Urban Education, which is an independent non-profit corporation, reports some of the findings in a study of the education of the deaf which was designed to stimulate a reconsideration of important educational practices. One of Mr. Kohl's study suggests the necessity for re-examining the education for the deaf to see if new approaches are possible.

A report of research by Ross Stuckless and Jack Birch[20] in a study of the influence of early manual communication on the linguistic development of deaf children concluded that early manual communication facilitates the acquisition of speech reading and receptive and expressive language skills but has no negative influence on the psychosocial development of these children; rather, it may have a positive effect. This indicates that very young deaf children who were provided a manual communication system developed subsequent reading, written language, and speech reading skills superior to the deaf children who are without early systematic communication.

These findings would support Dr. Boatner's[21] conclusion in an address given to the First Joint Convention of the California Association of Parents of Deaf and Hard of Hearing Children in November, 1965, at which time he stated, "Language is the foundation stone without which no educational structure can be erected." Dr. Boatner's address cites several of the studies mentioned concerning low achievement of deaf children passing through schools for the deaf and supports the conclusions of other researchers who believe, like Kohl, that it is necessary to re-examine the education for the deaf and see if new approaches are possible. As Dr. Boatner[22] stated, "We need every club in the golf bag, speech, lip reading, auditory training; all pursued to, but not beyond, the law of diminishing returns, and greatest of all, we need language and reading, without which we cannot move forward."

New Approaches to Instruction of the Deaf

Several studies are being performed at the present time aimed toward re-evaluating current educational practices so that improvement in the education of deaf students may be accomplished. These studies include a report of an investigation of instrumentation, establishment, and operation of a learning laboratory for hard-of-hearing children by Dr. Robert E. Stepp.[23] Also, Dr. Richard F. Krug[24] reports a new approach to the teaching of language to young deaf children, which emphasizes syntax and word order to accelerate the development skills for young deaf children. Stuckless and Marks[25] in a study, "The Assessment of Written Language of Deaf Students," report that deaf students depend heavily upon written language, that pictures elicit more response than words in the instructional setting, and rendered an opinion that language instruction should be continued through the secondary level.

In recognition of changing needs in education practice, the Illinois School for the Deaf, for example, has installed auto-instructional teaching stations in residence areas with provisions for the eventual installation of closed curcuit television stations. This unit has been designed with attention to future expansion of educational techniques which take advantage of improved methods of instruction. It is designed for maximum involvement of the residence and educational staffs so that there will be a smooth transition between classrooms, residence hall, and home.

Further support for using more and better educational media techniques and materials is emphasized by increasing federal and state support to schools for the deaf. One of the most significant contributions has been the support for equipment, materials, and in-service training available through Captioned Films for the Deaf, U. S. Office of Education.

Objectives

As stated previously, the project had three major objectives. The first was to determine what refinements and modifications were necessary to adapt transparency visuals designed for regular public school classes to meet the specialized instructional program needs of totally deaf students. This objective was completed during the first twelve months of the project which was designed as phase one of the modification of the visuals.

Objective number two was to ascertain whether special modifications increase effectiveness of visuals in the education of deaf students. This objective was completed during phase two of the project and included the testing of the five sets of modified visuals in seven state schools for the deaf. This was perhaps the major objective of the project and the most difficult to accomplish. Statistical design required that students be randomly assigned to two groups within each subject area, one to be the experimental group, and the other the control group. The students were then given a pre-test prior to the beginning of instruction in the 1966-67 school year. The experimental group was taught with modified visuals and the control group with unmodified visuals. At the end of the 1966 school year a post-test was given. The pre-test and post-test were identical and were made up of questions designed to test the knowledge of the content of each visual, one question per visual. The data was then subjected to computer analysis for significant differences.

Working on grammar and structure of the project report are: Left to right, Mr. Jacobs, Mr. Powell, Mrs. Morrison, and Miss Thomas.

The third objective was to utilize the Texas-developed and classroom-tested overhead projection transparencies to study the effectiveness of such visual materials in the instruction of deaf students. A general objective such as this was difficult to measure by conventional statistical methods. Therefore, objective number three was evaluated primarily in terms of subjective opinions collected from the experienced educators of the deaf who participated directly in the testing phase of the project. This objective was evaluated by means of questionnaires completed by teachers and supervisors in each of the participating schools.

II. PROCEDURE

Modification of Visuals (Phase I)

Phase I of the project began on September 1, 1965. Five classes at the Texas School for the Deaf were chosen as experimental classes to participate in the modification phase of the project. Five teachers were chosen because of their demonstrated competencies in the five subject areas which were to be the subject of the research project. The classes in Mathematics 7, Algebra, Geometry, World Geography, and Earth Science were supplied with complete sets of regular public school visuals from the Texas Transparency Project. The five teachers were participants in an orientation conference on the use of the overhead projector. Mr. William Jackson, who was then with the Pilot School for the Deaf and the Callier Hearing and Speech Center in Dallas, Texas, held the one day workshop in which these five teachers were acquainted with the best technique in utilizing the overhead projector and overhead projection transparencies.

On September 1, the five teachers began using the regular public school visuals in the classes for the deaf. As the visuals were used, they were evaluated by the teacher of the deaf and the students individually, to decide if modification were indicated and, if so, which changes should be made. Teachers were advised that this portion of the project was definitely a modification activity and was not aimed at creating new visual materials.

The teachers were provided with a visual evaluation sheet to complete on each visual concerning the content and appearance of the visual. As shown in Figure I, some of the questions referred to the stimulus value of the transparency--was it interesting, attractive, or distracting? Vocabulary was evaluated according to difficulty and pertinence in teaching the concept. The content was evaluated in terms of potential for concept development and simplicity and clarity of presentation. If the concept under consideration warranted special emphasis, an explanatory transparency was added prior to the introduction of the original. Projection was an important item and one of the questions concerned the ease with which the students were able to see every part of the transparency.

After having completed the evaluation, the teachers were then asked to suggest modifications of the transparency to make it more usable with the deaf student. Each Friday, the Project Coordinator conferred with the five participating teachers and reviewed the suggested modification of visuals which were completed during the previous week. On Monday morning these visuals were discussed with subject matter consultants on the staff of the Texas Education Agency. The consultants were specialists in mathematics, world geography, and earth science. During this conference, the suggested modifications by the teachers of the deaf were reviewed and affirmed or revised depending upon the decision of the subject matter consultants. The project coordinator then clarified the suggested modifications, if necessary, on each one of the visuals, conferred with the supervisor of the graphics laboratory staff, and explained the requested modifications for each of the visuals. The supervisor of the laboratory then distributed the visuals among the staff artists to make the recommended changes. As modifications were made, the masters were returned to the project coordinator for review at which time he examined them closely for consistency, accuracy of modification, and error. The masters, if acceptable, were returned to the graphics laboratory for reproduction into a completed modified visual. As the modified visuals were completed, they were returned to the subject matter specialist on the staff of the Texas Education Agency for review and approval. If approved, they were returned to the teacher of the deaf for review and approval. After having been approved by the Agency consultants, project coordinator, and the staff of the deaf school, the revised transparencies were coded and placed in the file as a part of the five new modified sets.

This procedure was followed throughout the school year of 1965-66. In May of 1966 all of the regular public school visuals had been reviewed and modifications had been completed.

During Phase I of the project, the coordinator contacted schools for the deaf throughout the United States and selected schools to participate in the testing phase of the project. The major determining factor was necessarily the size of the school. In an effort to insure adequately large sample classes for the testing phase, seven schools were selected. Those chosen included schools in California at Berkeley and Riverside; Texas; Florida;

Georgia; North Carolina; and the American School for the Deaf at Hartford, Connecticut.

During the summer of 1966, the Texas Education Agency graphics laboratory prepared approximately 60 sets of visuals, 5000 visuals with colors, overlays, and special effects, both modified and unmodified. These visuals were to be used in the testing phase of the project.

Testing of Modified Visuals (Phase II)

In August of 1966, each participating school for the deaf was asked to send two representatives to the Texas Education Agency for an orientation conference prior to the initiation of Phase II of the Project. During this three day conference, participants were oriented thoroughly concerning the modification phase and the goals and procedures to follow in the testing phase. They were also given an opportunity to consult with the teachers at the Texas School for the Deaf who were responsible for the suggested modification of the visuals. Phase I teachers advised participants of the testing phase of some errors in procedure to avoid. An example of an error in procedure was the failure of some of the Phase I teachers to adhere to lesson plans. The result was that a large number of unused visuals accumulated toward the end of the school year. Other usage problems which arose during the modification phase were shared with the consultants for Phase II. The participants were shown the new modified and unmodified materials, visual by visual, to familarize them with the types of modifications made. The guide books which accompanied the visual sets were introduced, and details of the testing procedure outlined.

When completely oriented as to the procedures to follow during the testing phase of the project, the conference participants returned to their respective schools and immediately held an orientation conference for all the teachers for the testing phase. During this conference they advised the teachers of their responsibilities. They conveyed essentially the same information using the same orientation guidelines for instructing the teachers as they had experienced in the August orientation conference which was a model for the field conferences.

To insure that the testing phase of the project was carried out to exact specifications, representatives of the Texas Education Agency who had attended the August orientation conference visited each participating school to evaluate initial progress, advise on continuing procedure for accomplishing goals of Phase II, and to correct any procedural errors which might be found. A few errors were discovered but all errors found were minor and were not judged to interfere with the effectiveness or reliability of the project. Minor errors included, for example, the continuation of a class for the first weeks of the testing phase without a textbook or omitting from the procedure an important request that the pre-tests either be destroyed or returned to the Texas Education Agency. These errors were corrected in the first few weeks of Phase II.

During the summer of 1966, the test classes for each subject area in each school were chosen and data was collected on pupils in the test classes. The data included age, intelligence quotient and type of test administered, most recent achievement test, grade classification level, and audiogram results. Each subject area was divided into two classes and placed under the instruction of one teacher. In one class the teacher was required to use modified visuals, in the other class unmodified visuals were used. The teacher was admonished to follow the same procedure, lesson plan, and use of supplementary materials in both classes, treating the classes as nearly alike as possible. Students in an experimental group using modified visuals were not allowed to see visuals used by the control class.

Before school began a test covering the content for each subject area was given to all participating students. This test consisted of one question for each visual in each subject area and was made appropriate to both the modified and unmodified visuals. This was possible since the content of the visuals was not changed in the modification procedure. The pre-test was administered in multiple choice form with four choices possible. The content test was prepared by the teachers of the deaf during the modification phase and was reviewed and edited by the subject content specialists on the staff of the Texas Education Agency. These were then reviewed for gross error by the statistical consultant and the project coordinator. The student answered the test questions by use of a data processing answer sheet which was placed in an automatic data processing test scoring machine from which a computer card was prepared and completely coded for analysis by the computer. When the pre-test computer cards were complete, they were computer analyzed by the statistical consultant for consistency and accuracy. The cards were found to be consistent, accurate, and reliable for use in later analysis.

As the testing phase of the project progressed, the project coordinator maintained close contact with the participating schools. Questions of procedure that arose or problems that were encountered, were dealt with immediately.

In May of 1967, the content post-test was administered in the same manner in which the pre-test had been given, and the data was entered in the computer for analysis.

Under the direction of Mr. Bonner, Mrs. White, Mrs. Williams, and Mr. Gover review the statistician's report.

III. ANALYSIS OF THE TEST DATA

Report and Interpretation by Statistician

A variety of statistical techniques was applied to the data in order to illuminate as fully as possible the various areas of interest in the design. Some of the results were heavily over-lapping since the methods used were in some cases highly similar. Taken altogether, these analyses unequivocally supported the following general conclusions:

(1) Modification of the visuals had no measurable effect on the performances of the students on the criterion achievement test. This is not simply a finding of no "significant" differences between the paired classes taught by the same teachers; this variation was as much in one direction as the other.

(2) Tremendous variation was found among the 30 teachers in the design, in terms of the amount of gain achieved by their classes. Although one school appeared to yield consistently higher average gain scores, this finding is most accurately stated as reflecting differences among teachers rather than schools. In four out of five subject areas, over 50 percent of the post-test variation was associated with differences among teachers.

(3) Too many of the teachers--by any standard--failed to stimulate any appreciable learning on the part of their students. In 9 of the 60 classes there was actually a slight loss in performance between the pre-test and post-test administration (of the same items) nine months later. In 20 of the 60 classes the gain was less than five points. In contrast, the classes taught by some teachers gained an average of 20-30 points or more.

(4) As will be apparent from the technical descriptions which follow, the above findings cannot be explained in

terms of differences in student age, general intelligence, or level of pre-test performance. These factors were held constant statistically in the most stringent analyses of those performed.

Attrition

Table 1 indicates the distribution of the 514 students among the 60 classes tested. The original student rosters listed a total of 567 students; the attrition rate was the same (9 percent) for classes using both modified and unmodified visuals. Among subject areas the attrition rate ranged from 6 percent (Mathematics 7) to 13 percent (Algebra). Among schools the rate varied from 0 percent to 22 percent. "Attrition" in this case includes subjects dropped because of invalid test protocols, as well as those who failed to complete the course for various reasons.

TABLE 1

STUDENTS IN EACH OF 30 CLASSES (COMPLETE DATE)
U--UNMODIFIED, M--MODIFIED

		Algebra	Earth Science	Math Seven	Geography	Geometry	Totals
Alpha	U	6	9	10	10	7	42
	M	8	7	9	12	6	42
Beta	U	9	6	10	9	9	43
	M	6	6	10	9	9	40
Gamma	U	10	8	12	8	7	45
	M	6	7	8	8	8	37
Delta	U	6	9	10	9	9	43
	M	10	10	9	7	9	45
Epsilon	U	8	11	11	11	0	41
	M	11	11	11	11	0	44
Zeta	U	9	9	0	10	8	36
	M	10	10	0	9	9	38
Eta	U	5	4	0	0	0	9
	M	5	4	0	0	0	9
Totals	U	53	56	53	57	40	259
	M	56	55	47	56	41	255

Pre-Test and Post-Test Statistics

Table 2 contains the means, sigmas, and alpha coefficients of reliability for the pre-testing and post-testing in each of the five subject areas. The reliability coefficients indicate a satisfactory degree of internal consistency, justifying further analysis of grouped data. All five subject areas show an average increase in performance from pre-testing to post-testing, although it will be apparent later that this varies a great deal from one teacher to another. The increased variance of scores for Mathematics 7 and for Geometry is not unexpected since the pre-test was a baseline examination.

TABLE 2

PRE-TEST AND POST-TEST STATISTICS

	Mean	Sigma	Alpha
Algebra (102 items)			
Pre-Test	16.21	9.43	.82
Post-Test	45.84	9.70	.81
Earth Sciences (54 items)			
Pre-Test	16.21	5.36	.69
Post-Test	24.46	5.96	.69
Math Seven (55 items)			
Pre-Test	17.74	4.98	.61
Post-Test	25.46	8.15	.84
Geography (117 items)			
Pre-Test	40.38	13.79	.89
Post-Test	51.58	12.94	.85
Geometry (130 items)			
Pre-Test	27.64	11.86	.86
Post-Test	50.63	17.79	.92

Intercorrelation Analyses

Table 3 contains the means, sigmas and intercorrelations among the five basic scores considered in the analyses to follow. In all five subject areas amount of gain was positively correlated with both birthdate (last two digits of year) and IQ (estimated in many cases). The patterns of correlations among pre, and post, and gain scores are typical of this type of achievement testing. The low pre-post correlations suggest considerable variation among the intervening influences (teaching) on the students.

TABLE 3

INTERCORRELATION ANALYSES

Algebra (N = 109)

	Birth	IQ	Pre	Post	Gain	Mean	Sigma
Birth		.11	-.05	.18	.17	48.69	1.10
IQ	.11		.02	.17	.11	109.59	12.49
Pre	-.05	.02		.09	-.66*	31.03	9.43
Post	.18	.17	.09		.69*	45.84	9.70
Gain	17	.11	-.66*	.69*		14.82	12.93

Earth Sciences (N = 111)

	Birth	IQ	Pre	Post	Gain	Mean	Sigma
Birth		.27*	-.20*	.37*	.39*	50.51	1.48
IQ	.27*		-.01	.24*	.18	107.59	15.42
Pre	-.20*	-.01		-.08	-.68*	16.21	5.36
Post	.37*	.24*	-.08		.79*	24.15	6.32
Gain	.39*	.18	-.68*	.79*		7.95	8.62

Math Seven (N = 100)

	Birth	IQ	Pre	Post	Gain	Mean	Sigma
Birth		.41*	-.11	.12	.17	50.79	1.32
IQ	.41*		.01	.15	.13	106.58	14.03
Pre	-.11	.01		.16	-.41*	17.74	4.98
Post	.12	.15	.16		.83*	25.46	8.15
Gain	.17	.13	-.41*	.83*		7.72	8.83

Geography (N = 113)

	Birth	IQ	Pre	Post	Gain	Mean	Sigma
Birth		.21*	-.25*	.19	.30*	49.50	2.11
IQ	.21*		.02	.12	.07	108.72	15.15
Pre	-.25*	.02		-.09	-.76*	40.38	13.79
Post	.19	.12	-.09		.72*	51.58	12.94
Gain	.30*	.07	-.76*	.72*		11.19	19.78

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*Significant at the 95% level of confidence

TABLE 3--Continued

Geometry (N = 81)

	Birth	IQ	Pre	Post	Gain	Mean	Sigma
Birth		.00	-.02	.23*	.17	49.11	1.14
IQ	.00		-.22*	.30*	.32*	111.83	11.81
Pre	-.02	-.02		-.36*	-.74*	27.64	11.86
Post	.23*	.30*	-.36*		.89*	50.63	17.79
Gain	.17	.32*	-.74*	.89*		22.99	24.68

Analyses of Gain Scores

Table 4 contains the results of five double-classification factorial analyses of variance using gain scores as the criterion (dependent) variable. The two independent variables in each design were Visuals (unmodified, modified) and Schools (teachers). Since only one teacher taught each subject in each school to two classes, the "schools" effect could have been labeled "teachers."

In all five subject areas the visuals factor yielded virtually no variation, while the schools/teachers factor was highly significant. The "p" values in Table 4 are the probabilities that the obtained differences are due only to chance. In three of the five subject areas, the interaction of teacher and visual-type was significant, which means that the differences between paired classes were not consistent across teachers.

TABLE 4

ANALYSIS OF VARIANCE OF GAIN SCORES

Algebra

	Unmod	Mod	Total
Alpha	16.0	14.1	15.1
Beta	2.1	- 3.2	- 0.5
Gamma	21.3	20.5	20.9
Delta	- 1.2	14.5	6.7
Epsilon	6.8	5.8	6.3
Zeta	31.7	34.9	33.3
Eta	20.8	15.2	18.0
Total	13.9	14.6	

Significance Tests
Schools: $p < .00005$
Visuals: $p = .6498$
Interaction: $p = .0014$

Earth Sciences

	Unmod	Mod	Total
Alpha	8.7	9.3	9.0
Beta	1.0	-0.2	0.4
Gamma	.6	-0.1	0.2
Delta	4.7	10.1	7.4
Epsilon	8.6	7.8	8.2
Zeta	18.2	21.2	19.7
Eta	7.0	0.5	3.8
Total	7.0	6.9	

Significance Tests
Schools: $p < .00005$
Visuals: $p = .9774$
Interaction: $p = .2415$

Math Seven

	Unmod	Mod	Total
Alpha	5.0	5.3	5.2
Beta	- 1.2	1.4	0.1
Gamma	22.0	14.1	8.1
Delta	7.5	2.8	5.1
Epsilon	4.6	13.1	8.8
Total	7.6	7.3	

Significance Tests
Schools: $p < .0005$
Visuals: $p = .8313$
Interaction: $p = .0005$

TABLE 4--Continued

Geography

	Unmod	Mod	Total
Alpha	8.6	6.2	7.4
Beta	-12.9	-10.4	-11.7
Gamma	2.9	- 0.3	1.3
Delta	25.3	16.9	21.1
Epsilon	2.5	8.5	5.5
Zeta	38.9	48.6	43.7
Total	10.9	11.6	

Significance Tests
Schools: $p < .00005$
Visuals: $p = .7169$
Interaction: $p = .0676$

Geometry

	Unmod	Mod	Total
Alpha	51.4	43.5	47.5
Beta	-03.15	.7	-01.2
Gamma	11.3	18.3	14.8
Delta	10.1	10.7	10.4
Zeta	46.4	53.3	49.9
	23.2	25.3	

Significance Tests

Schools:	$p < .00005$
Visuals:	$p = .5190$
Interaction:	$p = .5446$

To explore further the differences between paired classes, a series of 30 two-group analyses were carried out with the raw post-test score, gain score, and regression-adjusted residual gain score as successive criteria. The results with the three dependent variables were the same for all practical purposes. They are abstracted in Table 5 which simply reports the number of class pairs in which the un-modified visual class had a greater average gain than did its paired class using modified visuals, and vice versa. It is apparent that modification of the visuals had no general impact on performance and that only a moderate degree of variation exists across subject areas in this regard.

TABLE 5

DIRECTIONS OF MEAN GAIN DIFFERENCES BETWEEN PAIRED CLASSES

	Unmod	Unmod	Totals
Algebra	5	2	7
Earth Sciences	4	3	7
Math 7	2	3	5
Geography	3	3	6
Geometry	1	4	5
totals	15	15	30

Regression Analyses of Post Scores

The final and most definitive analysis of the data employed all of the available data described previously in the intercorrelation analyses. The post-test score was treated as the criterion to be predicted (explained) by (1) the pre-test score, (2) the birthdate, (3) the IQ estimate, (4) type of visuals employed, and (5) the school (teacher) concerned. Each subject area was treated as a separate problem.

Four regression equations (models) were established in each problem:

A. Post = classes + pre + IQ + birth + error (A)

B. Post = schools + visuals + pre + IQ + birth + error (B)

C. Post = schools + pre + IQ + birth + error (C)

D. Post = pre + IQ + birth + error (D)

Note that each successive model contains less predictor information and hence will contain more error. The questions to be answered with significance tests are whether the information lost in a particular model reduction was significant (not due only to chance). Three F-tests were computed to answer these questions (see tables 6-10).

1. Models A-B measures the variation among teachers in the differences between their paired classes, other than those differences systematically related to the visuals used.

2. Models B-C measures systematic variation between classes using the two types of visuals. This is the crucial question posed at the beginning of the project.

3. Models C-D measures systematic variation among schools (teachers) when paired classes are combined.

Note that all four models contain pre-test, IQ, and birthdate information. Therefore, all observed variation between models is beyond that associated with these three control variables. This technique is sometimes called "analysis of covariance", and is equivalent to systematic matching of the subjects.

The R^2 coefficient associated with a particular model is the squared multiple correlation of the predictors with the post-test criterion score. It may be directly interpreted as the proportion of criterion variance "explained" by the predictor information. Similarly, the difference in R^2 for two models where one is a subset of the other may be interpreted as the percentage of variation due to the dropped information--in the presence of the information common to both models.

TABLE 6

PREDICTION OF POST-TEST SCORES IN ALGEBRA

Model A	$R^2 = .6388$	
Model B	$\underline{R^2 = .5789}$	Interaction
Difference	5.99%	
F-Ratio = 2.542	df = 6/92	p = .0251
Model B	$R^2 = .5789$	
Model C	$\underline{R^2 = .5789}$	Visuals
Difference	0%	
F-Ratio = 0.000	df = 1/98	p = 1.0000
Model C	$R^2 = .5789$	
Model D	$\underline{R^2 = .0633}$	Schools
Difference	51.56%	
F-Ratio = 20.201	df = 6/99	p = .00005

Visuals as such make no contribution to predicting post-test scores. Six percent of the variation is due to difference between classes taught by the same teacher, while 52 percent of the variance is due to difference among teachers.

TABLE 7

PREDICTION OF POST-TEST SCORES IN EARTH SCIENCE

Model A	$R^2 = .3826$	
Model B	$R^2 = .3423$	Interaction
Difference	4.03%	
F-Ratio = 1.023	df = 6/94	p = .4159
Model B	$R^2 = .3423$	
Model C	$R^2 = .3316$	Visuals
Difference	1.07%	
F-Ratio = 1.630	df = 1/100	p = .2019
Model C	$R^2 = .3316$	
Model D	$R^2 = .1563$	Schools
Difference	17.53%	
F-Ratio = 4.413	df = 6/101	p = .0008

Visuals as such make no significant contribution to predicting post-test scores. Five percent of the variation is due to differences between classes taught by the same teacher, while 18 percent of the variance is due to differences among teachers.

TABLE 8

PREDICTION OF POST-TEST SCORES IN MATHEMATICS 7

Model A	$R^2 = .6363$	
Model B	$R^2 = .5114$	Interaction
Difference	12.49%	
F-Ratio = 7.472	df = 4/87	p = .0001
Model B	$R^2 = .5114$	
Model C	$R^2 = .5109$	Visuals
Difference	.05%	
F-Ratio = .089	df = 1/91	
Model C	$R^2 = .5109$	
Model D	$R^2 = .0554$	Schools
Difference	45.55%	
F-Ratio = 21.419	df = 4/92	p = .00005

Visuals as such make virtually no contribution to predicting post-test scores. Thirteen percent of the variation is due to differences between classes taught by the same teacher, while 46 percent of the variance is due to differences among teachers.

TABLE 9

PREDICTION OF POST-TEST SCORES IN GEOGRAPHY

Model A	$R^2 = .6038$	
Model B	$R^2 = .5532$	Interaction
Difference	5.06%	
F-Ratio = 2.505	df = 5/98	p = .0348
Model B	$R^2 = .5532$	
Model C	$R^2 = .5454$	Visuals
Difference	.77%	
F-Ratio = 1.783	df = 1/103	p = .1814
Model C	$R^2 = .5454$	
Model D	$R^2 = .0464$	Schools
Difference	49.90%	
F-Ratio = 22.837	df = 5/104	p = .00005

Visuals as such make no significant contribution to predicting post-test scores. Six percent of the variation is due to differences between classes taught by the same teacher, while 50 percent of the variance is due to differences among teachers.

TABLE 10

PREDICTION OF POST-TEST SCORES IN GEOMETRY

Model A	$R^2 = .6749$	
Model B	$R^2 = .6669$	Interaction
Difference	.8%	
F-Ratio = .417	df = 4/68	p = .7980
Model B	$R^2 = .6669$	
Model C	$R^2 = .6669$	Visuals
Difference	0%	
F-Ratio = 0.0	df = 1/72	p = 1.0000
Model C	$R^2 = .6669$	
Model D	$R^2 = .2270$	Schools
Difference	43.99%	
F-Ratio = 24.100	df = 4/73	p = .00005

Visuals as such make no contribution to predicting post-test scores. One percent of the variation is due to differences between classes taught by the same teacher, while 44 percent of the variance is due to differences among teachers.

Analysis of Incidental Data

Visual Evaluation Sheets

A visual evaluation sheet accompanied each unmodified visual during the modification phase (Phase I). Participating teachers filled out a sheet for each visual as it was completed. Individual evaluation of each visual was important for two reasons. First, its completion required the teacher to give careful consideration to several aspects of each visual. To complete the evaluation sheet the teacher had to ask several pertinent questions about it. Second, evaluation results clearly identified deficiencies within visuals. If one was not interesting, what could be added to make it interesting? If the visual did not help teach the concept, how could it be modified to do so? The visual evaluation sheet was, then, an assist to the teachers--a work sheet.

Several conclusions of nominal importance may be drawn from a compilation of the results of all the sheets combined. Figure 1 indicates that generally the unmodified visuals were interesting, attractive and free of distractions. The vocabulary was generally not too difficult, was usually necessary to teaching the concept and usually did not require additional visuals to explain vocabulary used. The unmodified visuals almost always helped teach the concept as it existed and usually every item was clearly visable to every student when projected.

If the project goals were accomplished in this respect, these same evaluation sheets completed on the modified visuals would show 100 percent

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positive responses where deficiencies were identified. Although optimum results are not usually anticipated, use of the visual evaluation sheet certainly improved the quality of modifications. It is interesting to note also that generally positive responses in evaluation of the unmodified visuals is consistent with the responses on the teacher questionnaire and substantiates the conclusion concerning the major hypothesis of no significant difference between visuals.

Mr. Mergener and his group, consisting of Mr. Curtis, Mr. Butler and Miss Benton work on the appendices and tables for the final report.

TABLE 11

COMBINED RESULTS OF VISUAL EVALUATION SHEETS FROM MODIFICATION PHASE

	Percent of Total Responses Per Item											
	Algebra		Math		Geometry		Geography		Science		All Five Areas	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
I. STIMULUS VALUE OF THE TRANSPARENCY												
Is it interesting?	99		100		100		100		98		99	
Is attention attracted to the concept?	100		100		100		100		94		98	
Are there distractions?		99		100		100		100		83		95
II. VOCABULARY OF THE TRANSPARENCY												
Is the vocabulary too difficult?		100		100		100		83		94		90
Is the vocabulary necessary in teaching the concept?	97		89		100		100		90		94	
If the vocabulary is necessary in teaching the concept, would additional transparencies explaining the words be helpful? (To precede original transparency)		100		97		100		100		92		
III. CONCEPT OF TRANSPARENCY												
Does the transparency help teach the concept?	100		100		100		100		92		98	
Is there more than one concept presented?		62		59		86	67			66		80
Should only one be presented on this transparency?	57			57	57			67	88		61	
Should the transparency be simplified?		95				100		83		60		80
Does the concept presented depend upon the students having previously learned one or more concepts basic to understanding this transparency?	100		96		100		80		87		95	
IV. PRODUCTION												
Is every item on the transparency clearly visible to every student?	99		100		100		100		76		93	

Cumulative Data on Types of Modifications

In order to record data concerning the types of modifications being made during Phase I, major categories and more specific sub-categories were created. The three major categories were Category I--no modification, Category II--modification by type, and Category III--corrections. (See Table 12, 13, and 14). Categories I and III are self-explanatory. Some visuals needed no modification and some contained errors which were corrected but not modified. Category II was divided into seven sub-categories identifying such adaptations as complete redesign, addition of explanatory visual, division of one visual into two or more simpler ones, vocabulary change, legend improved enlargement, and design improvement.

As new modified visuals were completed and reviewed during Phase I, the project coordinator coded each one and filed these by sets for later compilation as shown in Tables 12, 13, and 14.

This data concerning types and frequency of modification is an index to the amount of adaptation required and type of modification which was required most frequently.

Results in Table 12 seems innocuous enough; however, there are at least two significant conclusions which may be drawn from this data. First, in mathematics necessity for modification is so infrequent and insignificant that visuals in mathematics created for regular public school children probably do not need to be modified; or, more accurately, they probably cannot be modified significantly without substantial change in content which,

TABLE 12

COMBINED RESULTS OF VISUAL EVALUATION SHEETS FROM MODIFICATION PHASE

MATHEMATICS CONTROL SETS

SUBJECT	NO MODIFICATION	TYPE OF MODIFICATION		
		Visual Added	Wording Changed	Corrections
Algebra 102	94.00	1.00	5.00	
Math. 7 55	53.00		1.00	
Geometry 137				24
Totals 464	260.00 (88.44%)	1.00 (34.00%)	6.00 (2.04%)*	

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*Percentages represent percent of total visuals within sets

if diminished, decreases materially the breadth and depth of the materials for instruction. Although not at first contemplated, the math sets required so few modification that they were used in the final analysis to substantiate the validity of the samples at random. If a significant difference in achievement on the post-test occurred in any one of the math categories, the difference would have to be attributable to something other than differences between visuals. Since other variables were controlled, any difference would have to be due to sampling error. No difference occurred confirming to some extent the validity of the technique of random assignment and equivalency between control and experimental groups. The second conclusion concerns the number of errors found in the unmodified visuals. There were 24 errors in the Geometry set. This finding illustrates the need for careful review and pilot-testing of newly created sets of visuals.

Table 13 shows the frequency and type of modification in the Earth Science and World Geography sets. The most frequent type of change in the Earth Science visuals was to divide 12 of the 53 visuals into a series of two or more. On eight of them, the artist improved the visual component of the transparency. It is interesting to note that 57 percent of the participating teachers did not think separate visuals (series) are superior to multiple overlays for teaching difficult concepts. Also, 71 percent of the teachers judged the visual content to be generally simplified enough. In the World Geography set, 36 of the 59 visuals required improvement of legends. Actually this type of change should not have been necessary. If

TABLE 13

CUMULATIVE MODIFICATION DATA ON EARTH SCIENCE AND WORLD GEOGRAPHY VISUALS

SUBJECT	NO MODIFICATION	Redesign	Visual Divided to Series	Wording Changed	Legend Improved	Key Area or Letter Enlarged
Earth Science 53	26.00	1.00	12.00	1.00	3.00	
World Geography 117	59.00	5.00	1.00	9.00	36.00	1.00
Totals 464	85.00 (50.00%)	6.00 (3.53%)	13.00 (7.65%)	10.00 (5.88%)	39.00 (22.94%)	1.00 (.59%)*

---

*Percentages represent percent of total visuals within sets

the designers of the unmodified visuals had been experienced in the use of legends there would have been made in the unmodified whether used with the deaf or not.

Table 14 shows modifications on all sets combined by frequency and percentage. This figure indicates that approximately 50 percent of both Earth Science and World Geography were modified. In the Geometry set, 17.52 percent had to be corrected. Of the 464 visuals tested, 74.35 percent were judged to require no modification. The control Math sets lowered this percentage total of modifications; however, 50 percent of the test sets, Earth Science and World Geography, were modified.

TABLE 14

CUMULATIVE MODIFICATION DATA ON VISUAL SETS BY SUBJECT

FIVE SUBJECT AREAS COMBINED

SUBJECT	NO MODIFICATION	TYPE OF MODIFICATION					
		Redesign	Visual Added	Visual Divided to Series	Wording Changed	Legend Improved	Key Area or Letter Enlarged
Earth Science 53	26.00 (49.06%)	1.00 (1.89%)		12.00 (22.64%)	1.00 (1.89%)	3.00 (5.66%)	
World Geography 117	59.00 (50.43%)	5.00 (4.27%)		1.00 (1.86%)	9.00 (7.69%)	36.00 (30.77%)	1.00 (.85%)
Algebra 102	94.00 (92.16%)		1.00 (.98%)		5.00 (4.90%)		
Math 7 55	53.00 (96.36%)				1.00 (1.82%)		
Geometry 137	113.00 (82.48%)						
Totals 464	345.00 (74.35%)	6.00 (1.29%)	1.00 (.22%)	13.00 (2.80%)	16.00 (3.45%)	39.00 (8.41%)	1.00 (.22%)*

---

*Percentages represent percent of total visuals within sets

Teacher Questionnaire

Each participating teacher and supervising teacher was asked to complete the questionnaire shown in Table[15]. These responses reveal some interesting opinions which reflect, at least to some degree, consistency with empirical data analysis.

The findings were as follows:

> Thirty-one percent of the teachers felt they were able to progress faster with modified visuals.
>
> Forty-four percent felt that they were able to obtain more depth in the learning situation with the modified visuals.
>
> Forty-eight percent of the teachers felt the students seemed to understand modified visuals with less explanation than with the unmodified.
>
> Ninty-six percent of the teachers preferred the overhead projector to other types of projectors.
>
> Ninty-two percent found the visuals useful with a standard text.
>
> Ninty-two percent felt that colored visuals are more effective than uncolored visuals. Bright colors and consistent application of color were preferred to dark or pastels by over 80 percent of the teachers.
>
> There was not a single case of color blindness reported.

The responses indicate a majority of the teachers felt that the visual and verbal content on the unmodified sets was generally simplified enough without modification. Fifty percent opined that separate visuals are not superior to multiple overlays for teaching difficult concepts.

Considering the opinion of the teachers as reflected in the responses on the teacher questionnaire, it can be concluded that although the unmodified visuals are adequate in most critical areas of evaluation, modified visuals show some superiority when evaluated subjectively.

Some other general conclusions may be drawn from the questionnaire and an evaluation of the responses.

> Since language is a significant problem in the education of the deaf student, vocabulary must be kept to a minimum, and language structure must be in its simplest form.
>
> Teachers of the deaf using overhead transparencies and other types of supplementary materials should make a special effort to insure that students comprehend the language involved.
>
> Overhead projection transparencies used in the project were considered of great value and assistance in the teaching of concepts to deaf students.
>
> A transparency cannot be too simple.
>
> Teachers of the deaf prefer the flexibility of adding vocabulary rather than trying to explain vocabulary which has been included, but which may not be necessary to concept development.

Questions 6, 7, 8, 10, and 11 are interpreted as having special meaning because the teacher response was strongly positive. Obviously, then, classroom use of the overhead projector with modified transparencies usable with a standard text and colored with consistently bright colors is an effective means of imparting information to deaf students.

TABLE 15

TEACHER QUESTIONNAIRE

	Percent	
	Yes	No
1. Do you have color blind children in your class?		100
2. Were you able to progress faster with modified visuals than with unmodified?	31	69
3. Were you able to attain more depth in the learning situation with the modified visuals than with the unmodified?	44	56
4. Did students seem to understand modified visuals with less explanation than unmodified?	48	52
5. Did the content on some of the visuals require special teacher training before they could be used?	50	50
6. Do you prefer the overhead projector for use in the classroom to other types of projectors?	96	4
7. Did you find the visuals useable with a standard text?	92	8
8. Are colored visuals more effective than uncolored visuals?	92	8
9. Do you think the use of visuals allows for a more heterogeneous grouping?	71	29
10. Are bright colors more desirable than dark colors or pastels?	81	19
11. Do you think a consistant application of color (water, blue; grass, green; etc.) is more effective than random choice of color?	82	18
12. (a) Do you think the visual content on unmodified visuals was generally simplified enough?	71	29

	Percent	
	Yes	No
13. (a) Do you think verbal content on unmodified visuals was generally simplified enough?	61	39
(b) Do you think verbal content on unmodified was oversimplified?	15	85
14. Do you think the visuals covered enough of the difficult concepts of the subject?	78	12
15. Do you think separate visuals are superior to multiple overlays for teaching difficult concepts?	43	57

IV. DISCUSSION

Questions and Comments Concerning Data Analysis

General Conclusion Concerning Value of the Project

There is general agreement and strong feeling among participants in the Texas Education Agency's transparency modification project that the project is far more significant than it might appear. Deaf students, teachers of the deaf, administrators, researchers, and state department personnel have reaped mutual benefits from the human interaction in a cooperative drive toward the common goal of upgrading classroom materials. There has been observable professional improvement among those involved.

The educational programs for the deaf in the various states have an additional good fortune of having received sets of transparencies for use in their school programs. The overhead projector is presently the most effectively used piece of equipment in the educational picture of the deaf and these visuals, specifically designed for use with the hearing impaired, will be valuable aids for many years.

The tooling up process of schools for the deaf for full utilization of modern educational media has opened broad new vistas, but has precipitated a multitude of unknowns. The transparency modification project has fixed a steady beam on the fact that there is an overwhelming need for further research into the new means of communication. This project, then, should inspire others to make contributions to basic research--without which there can be no major upgrading of methodology, no improvement in the relationship of the human factor, and no satisfactory solutions and technological gain for the educational handicap of deafness.

Some Components of a High Quality Visual for Use With the Deaf

The test data resulted in the conclusion that the performance of the students using modified visuals was the same as that of students using the unmodified visuals. In completing the project, however, considerable knowledge was gained concerning design and adaptation of visuals for the deaf. In spite of the conclusion regarding the major hypothesis, in the opinion of the teachers and students using the visuals some were greatly improved by modification.

It is the opinion of the educators of the deaf connected with the project that a number of desirable characteristics of a visual to be used with the deaf have been identified. If these are present, the visual can be most effective in meeting the needs of deaf students.

Attributes of a good visual:

- Legends are brief.
- Only one concept is presented.
- Design is simple in format.
- Design is not cluttered.
- Language is kept to a minimum.
- Vocabulary is made as simple as possible.
- Technical terms are used only when necessary.
- Print is large enough to be easily read.
- Legend is clear.
- Bright colors are used.

- Colors are consistent with nature, i. e. blue sky, green grass.
- Sufficient contrast exists between colors or symbols.
- Few differences exist between visual and textbook.

Visuals having the qualities listed above provide for:

- Understanding on the part of the student for particular concepts
- A saving of time in presentation
- Less effort and preparation on the part of the teacher in teaching a concept
- Opportunity to add technical terms, vocabulary, and other elaboration as dictated by the needs of individual students
- Use with the less-gifted pupils (where it is most needed) as well as the more intelligent students
- Superior to teacher-made visuals
- Increased student interest

There are various means of making additions to a visual but it is difficult and many times impossible, to delete unwanted material.

Comments Concerning Statistical Results

Educators of the deaf concurred with the conclusion that the most significant factor in the post-test score variations was differences among schools (teachers).

In a discussion of the data a question was raised concerning the results of intercorrelation analysis in Table 8. The low pre-post correlation suggested in Table 8 suggests considerable variation among the intervening influences of the students. The visiting consultants questioned whether these "intervening influences" could have been uncontrolled intervening variables which influenced teacher effectiveness, i. e., negative gain scores for a particular teacher's class. This question seems reasonable; yet, it reflects a misunderstanding of the data results and analysis and is discussed here for others who might raise the same question concerning the report.

The "intervening influences" mentioned in the last sentence of the intercorrelation analysis on page 27 does not refer to different kinds of influences, but rather to different degrees of influence. There is no evidence regarding the nature of inter-teacher differences; there is strong evidence that they did vary considerably in their influence on pupils.

The fact of highly significant differences among teachers in performances of classes cannot be explained on the basis of uncontrolled variables. The observed differences among teachers can be attributed to a variety of sources, but there are considerable restrictions in this variety. The variation between classes taught by the same teachers was, relatively, very small. Any influence felt to nullify the "teacher's" effect would have to take this fact into account. There are such influences, but without more data their importance cannot be assessed. A similarity index (intraclass correlation) computed between paired classes was .93, indicating that inter-teacher influences were relatively minor.

Visiting consultants from participating schools pointed out some other questions which might be raised by educators who are close to some of the vexing problems of educating the deaf. What about reading ability of students? Motivation? Teacher knowledge?

Again these are valid questions. Did the analysis take these and other factors into account? The statistical design and empirical analysis either controlled these variables directly or held them constant. Reading ability was controlled partially by IQ data and through the design of the pre-tests and post-tests. They were designed with vocabulary as simple as possible and were administered as "power tests" with no time limit. To say that students at the secondary level who did not learn anything could not read, raises serious questions about the education of the deaf in general, and the competence of the teachers concerned in particular.

Student motivation and teacher knowledge are both influences that cannot logically be separated from the teachers themselves--and thus must be considered as part of the teachers' ability, especially "teacher knowledge."

In general, the questions raised by visiting consultants reveal considerable concern regarding the quality of the teaching in schools for the deaf. The facts show that great differences in the learning of the students under various teachers were found, and that relatively minor differences appeared between classes taught by the same teachers. Systematic differences among the schools are certainly present--but this does not necessarily mean that teacher quality was equal in all schools; in fact, it points from this conclusion. Students in the different schools might differ systematically in motivation and quality of prior instruction, but these effects can in no way be separated from the teachers who are responsible for them.

If further analysis of the "teacher" influence should be undertaken, six kinds of data on each of the teachers should be analyzed.

(a) education-training

(b) teaching experience

(c) hearing loss

(d) attitudes toward project

(e) time spent on subject (1 or 2 semesters, etc.)

(f) degree of use of visuals

The statistician who perhaps can be more objective than others involved in the project made the following statement in one of his reports describing the data analysis. "It seems to me that one strong suggestion of the study is the need to obtain more competent teachers for the deaf. It is apparent that some of the teachers achieved excellent results, but they were a small minority of the sample studied."

V. SUMMARY

Transparencies, for use on overhead projectors developed under the leadership of the Texas Education Agency, for regular public school classes were modified for use in the instruction of the deaf through the cooperative efforts of The Texas School for the Deaf, subject matter specialists from the Texas Education Agency, and the project coordinator.

The major goal of the project was to determine if adapting regular public school visuals to the special needs of deaf students produced significant increase in learning over the unmodified visuals when used with these students and the effectiveness of using transparencies in the instructional program of the deaf.

Modifications were made on sets developed for use in teaching secondary Earth Science, Modern Mathematics, Algebra, Geometry, and World Geography. Extreme care was taken to simplify the vocabulary, design, and color of the transparencies without changing the subject matter content.

Seven schools for the deaf in widely separated areas of the United States agreed to use both the modified and the unmodified visuals on an experimental basis, in comparable classes, both classes having the same teacher. At a late summer meeting representatives of the schools worked together for two days for orientation and instruction in the use of the visuals.

During the following school term, the modified transparencies for each subject area were used with experimental classes and the parallel unmodified visuals used with comparable control classes. The method of communication used by all teachers and students was relatively uniform.

Tests were administered prior to initial transparency instruction and repeated following completion of the program. Results from the pre-testing and post-testing were interpreted by a statistician.

The culmination of the project was a final meeting of persons supervising the student and teacher activities based on the use of the transparencies. At the meeting, all facets of the experimental project were discussed.

Analysis of the pre-test and post-test data indicated that there was no significant difference in achievement between experimental and control groups. This finding indicated that deaf students using modified visuals showed no significant difference in achievement over that made by the students using the unmodified visuals. It was, however, determined from the analysis of incidental data (i. e., teacher responses, accumulated data during modification phase, and opinion of participating educators) that although the hypothesis of no significant difference between "sets" as assists in the learning situation was proven, there was definitely a number of visuals which were improved by special modification. This finding, then, indicates that overhead transparencies produced for regular public school classes can be used effectively with deaf students with selective modifications on individual transparencies. These modifications may in many cases be completed by the teacher.

As a by-product of completing the project, a number of desirable characteristics of a high quality transparency were identified and are listed on p 55. These characteristics may exist in "teacher prepared" transparencies. When transparencies for the deaf are produced, either by teacher or otherwise, it is felt these characteristics should be incorporated, if at all possible, for maximum effectiveness.

Although the basic hypothesis concerning the visuals yielded no significant difference, a difference concerning teachers was found. There was a highly significant difference in achievement between students taught by different teachers. Under one teacher, for example, students in a subject on the average scored very high on the subject content post-test. In another school, however, under a different teacher in the same subject, the students actually appeared to unlearned content (post-test scores were lower than pre-test). In the discussion section of this report, control variables other than the teacher are dealt with in detail. The unavoidable conclusion concerning this highly significant finding is that some teachers are much more effective in teaching the deaf student. This conclusion is not, of course, new knowledge. There has been "good" and "poor" teaching since Hellenist times. However, here we have empirical data confirming the observation and it relates to educators of the deaf. This raises several questions which prompted the previous suggestion of a need for further research. "What is the difference between the effective teachers and the non-effective? Is it training, experience, hearing ability, or attitudes? If these characteristics can be identified and dealt with, can quality of education of the deaf be improved? These are questions which remain unanswered at present but may yield to further research.

One final important conclusion was drawn from the project. The project investigators recognized the vast different and divergent views which exist in the general field of education of the deaf child. So that all might have a voice in the procedure and results of the project, approximately 50 educators participated directly in the research. All participants had a voice, all made contributions, and all participated in the interpretation of the results. This approach proved so successful in the subjective opinion of the investigators and participants that it is strongly recommended as a valid and successful approach to educational research.

ABSTRACT

Transparencies, for use on overhead projectors developed under the leadership of the Texas Education Agency, for regular public school classes were modified for use in the instruction of the deaf through the cooperative efforts of The Texas School for the Deaf, subject matter specialists from the Texas Education Agency, and project coordinator.

Purpose. The major purpose of the project was to determine if adapting regular public school visuals to the special needs of deaf students produced significant increase in learning over the unmodified visuals when used with these students and the effectiveness of using transparencies in the instructional program of the deaf.

Procedure. Modifications were made on sets developed for use in teaching secondary Earth Science, Modern Mathematics, Algebra, Geometry, and World Geography. Extreme care was taken to simplify the vocabulary, design, and color of the transparencies without changing the subject matter content.

Seven schools for the deaf in widely separated areas of the United States agreed to use both the modified and the unmodified visuals on an experimental basis, in comparable classes, both classes having the same teacher. At a late summer meeting representatives of the schools worked together for two days for orientation and instruction in the use of the visuals.

During the following school term, the modified transparencies for each subject area were used with experimental classes and the parallel unmodified visuals used with comparable control classes. The method of communication used by all teachers and students was relatively uniform.

Tests were administered prior to initial transparency instruction and repeated following completion of the program. Results from the pre-testing and post-testing were interpreted by a statistician.

The culmination of the project was a final meeting of persons supervising the student and teacher activities based on the use of the transparencies. At the meeting, all facets of the experimental project were discussed.

Results and Conclusions. Analysis of the data indicated no significant difference in achievement between experimental and control groups. Deaf students using modified visuals showed no significant difference in achievement on the subject post-test than the students using the unmodified visuals. There was, however, a highly significant difference between teachers indicating a need for further research in this area. Subjective comments by participating teachers and data from the modification phase indicate that there is a definite need for modification on some visuals created for regular public school classes to make them more effective with deaf students. The project also identified desirable modifications and some characteristics of high quality overhead transparencies for the deaf. It was also concluded that using a sizable number of consultants in a cooperative approach to educational research is a successful and efficient method.

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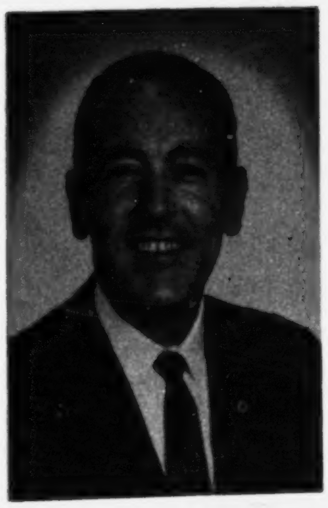

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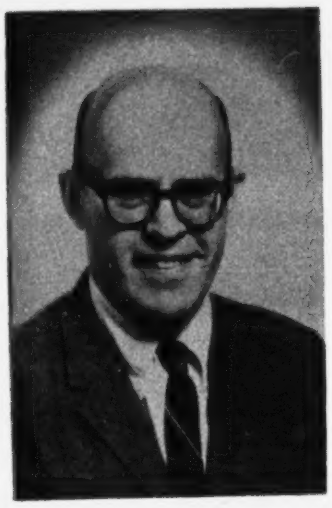

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B. Ed. - Western Illinois University

Mr. Lawrence R. Newman
Plane Geometry
B. A. - Gallaudet College
M. A. - Catholic University of America
17 Years Experience

Miss Jeanne Paul
Earth Science
B. S. - Northwestern University
12 Years Experience

Mr. Richard L. Plummer
Math 7
B. S. - Gorham State College
11 Years Experience

Mr. Leo Dicker
World Geography
B. S. - University of Wisconsin
M. S. - Gallaudet College
3 Years Experience